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EXAMINER

GEBREMARIAM, SAMUEL A

ART UNIT	PAPER NUMBER
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2811

DATE MAILED: 08/10/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/701,526

Applicant(s)

DORIS ET AL.

Examiner

Samuel A. Gebremariam

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 03 May 2005.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-26 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 26 is/are allowed.
- 6) ☒ Claim(s) 1-25 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- ☒ Notice of References Cited (PTO-892)
- ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____.
- ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____.
- ☐ Notice of Informal Patent Application (PTO-152)
- ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

2. Claims 1, 20, 21 and 23 are rejected under 35 U.S.C. 102(e) as being anticipated by En et al., US patent No. 6,573,172.

Regarding claim 1, En teaches a semiconductor structure (fig. 2I) formed on a substrate comprising: a plurality of field effect transistors (NMOS 102, and PMOS 104, transistors) having a first portion (NMOS) of field effect transistors (FETS) and a second portion (PMOS) of field effect transistors (col.; 3, lines 35-52, En teaches forming NMOS devices and PMOS transistors, therefore En teaches a plurality of field effect transistors); first stress layer (150) having a first thickness and being configured to impart a first determined stress to the first portion of the plurality of field effect transistors (NMOS region); and a second stress layer (130) having a second thickness and being configured to impart a second determined stress to the second portion of the plurality of field effect transistors (PMOS region, col. 7, lines 50-60).

Regarding claim 20, En teaches (fig. 2I) a process of forming a semiconductor structure, comprising: forming a plurality of field effect transistors on a semiconductor

substrate (106, col.; 3, lines 35-52, En teaches forming NMOS devices and PMOS transistors, therefore En teaches a plurality of field effect transistors), the plurality of field effect transistors including a first portion of field effect transistors (PMOS, 104) and a second portion of field effect transistors (NMOS, 102); depositing a first stress layer (130) having a first thickness and being configured to impart a first determined stress to the first portion of the plurality of field effect transistors (PMOS transistors); and depositing a second stress layer (150) having a second thickness and being configured to impart a second determined stress to the second portion of the plurality of field effect transistors (NMOS transistors).

Regarding claim 21, En teaches substantially the entire claimed structure of claim 20 above including removing portions of the first stress layer from areas of the semiconductor that would not experience performance enhancement due to the first determined stress (En teaches removing stress 130 from area of the NMOS region); and removing portions of the second stress layer (En teaches removing stress 150 from area of the NMOS region) from areas of the semiconductor that would not experience performance enhancement due to the second determined stress.

Regarding claim 23, En teaches (21) a semiconductor circuit comprising a substrate (106); a plurality of field effect transistors (col.; 3, lines 35-52, En teaches forming NMOS devices and PMOS transistors, therefore En teaches a plurality of field effect transistors) formed on the substrate (106), the plurality of field effect transistors including a first portion of field effect transistors (PMOS transistors 104) and a second position of field effect transistors (NMOS transistors, 102); a first stress layer (130)

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having a first thickness and being configured to impart a first determined stress to the first portion (PMOS) of the plurality of field effect transistors; and a second stress layer (150) having a second thickness and being configured to impart a second determined stress to the second portion of the plurality of field effect transistors (NMOS).

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. Claim 22 is rejected under 35 U.S.C. 103(a) as being unpatentable over En.

Regarding claim 22, En teaches substantially the entire claimed structure of claim 20 above except explicitly stating that the first thickness is less than the second thickness.

Parameters such as thickness in the art of semiconductor manufacturing process are subject to routine experimentation and optimization to achieve the desired device characteristics during fabrication.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to adjust the first and second thickness as claimed in order to form a CMOS device with improved performance.

5. Claims 2-11 and 24-25 are rejected under 35 U.S.C. 103(a) as being unpatentable over En in view of Tobben et al. US patent No. 6,235,574.

Regarding claims 2, 3 and 24-25, En teaches substantially the entire claimed structure of claims 1 and 23 above except explicitly stating that the first portion of the plurality of field effect transistors have spacing between adjacent field effect transistors that fall within a first defined spacing range; and the second portion of the plurality of field effect transistors have spacing between adjacent field effect transistors that fall within a second defined spacing range, where the first defined spacing range is less than the second defined spacing range.

Tobben teaches (figs. 1-6) the formation of a plurality of field effect transistors where the field effect transistors (the FETS formed in region 100A) have spacing between adjacent field effect transistors that fall within a first defined spacing range; and the second portion of the plurality of field effect transistors (the FETS formed in region 100B) have spacing between adjacent field effect transistors that fall within a second defined spacing range, where the first defined spacing range is less than the second defined spacing range.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form field effect transistors as taught by Tobben in the structure of En in order to form a high performance DRAM.

Regarding claim 4, En teaches substantially the entire claimed structure of claim 1 above including the first thickness does not pose a substantial risk of void formation in the first stress layer. No voids are formed in the structure of En.

Regarding claim 5, En teaches substantially the entire claimed structure of claim 1 above including the first determined stress enhances performance of the first portion of the plurality of field effect transistors, without materially degrading performance of any of the plurality of FETs that are not in the first portion; and the second determined stress enhances performance of the second portion of the plurality of field effect transistors, without materially degrading performance of any of the plurality of FETs that are not in the second portion (col. 2, lines 1-11).

Regarding claims 6-8, En teaches substantially the entire claimed structure of claim 1 above including the first portion of the plurality of field effect transistors is comprised of n-channel field effect transistors (NMOS); the first determined stress is a tensile stress (col. 7, lines 7-22); the second portion of the plurality of field effect transistors is comprised of p-channel field effect transistors (PMOS); and the second determined stress is a compressive stress (col. 6, lines 37-51).

The limitations that the first stress layer is formed by a chemical vapor deposition process using a temperature of about 480° C, a pressure of about 6.25 Torr, a spacing between the semiconductor structure and CVD electrode of about 490 mils, a flow of about 300 sccm of 2% dilute SiH₄ gas, about 15 sccm NH₃ gas and about 1060 sccm of NZ gas using RIF power of about 340 watts and the second stress layer is formed by a chemical vapor deposition process using a temperature of about 480°, a pressure of about 5.75 Torr, a spacing between the semiconductor structure and CVD electrode of about 395 mils, a flow of about 3000 sccm of 2% dilute SiH₄ gas, about 15 sccm of NH₃ gas and 1060 sccm of NZ gas using RF power of 900 watts are not given patentable

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weight because it is considered a product-by-process claim. "[E]ven though product-by process claims are limited by and defined by the process, determination of patentability is based on the product itself. The patentability of a product does not depend on its method of production. If the product in the product-by-process claim is the same as or obvious from a product of the prior art, the claim is unpatentable even though the prior product was made by a different process." *In re Thorpe*, 777 F.2d 695, 698, 227 USPQ 964, 966 (Fed. Cir. 1985).

Regarding claim 9, En teaches (fig. 21) substantially the entire claimed structure of claims 1, 4 and 6 above including the first portion of the plurality of field effect transistors is comprised of n-channel field effect transistors; the first determined stress is a tensile stress (col. 7, lines 7-22); the first defined spacing range is less than the second defined spacing range and the first thickness does not pose a substantial risk of void formation in the first stress layer.

En does not teach the second portion of the plurality of field effect transistors is comprised of n-channel field effect transistors; the second determined stress is a tensile stress; the first thickness is less than the second thickness.

En teaches that a tensile stress enhances the performance of an NMOS device. Furthermore Tobben shows the formation DRAM structure with a plurality of NMOS and PMOS transistors.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form a second portion of the plurality of field effect transistors

comprised of n-channel field effect transistors as claimed in the combined structure of En and Tobben in order to form a high performance DRAM structure.

Furthermore parameters such as thickness in the art of semiconductor manufacturing process are subject to routine experimentation and optimization to achieve the desired device quality during fabrication.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to adjust the thickness of the first and second thickness as claimed in the combined structure of En and Tobben in order to form a high performance DRAM structure.

Regarding claim 10, En teaches (fig. 21) substantially the entire claimed structure of claims 1 and 5 above including the first portion of the plurality of field effect transistors is comprised of p-channel field effect transistors (PMOS); the first determined stress is a compressive stress (col. 6, lines 37-51); the first defined spacing range is less than the second defined spacing range and the first thickness does not pose a substantial risk of void formation in the first stress layer.

En does not teach the second portion of the plurality of field effect transistors is comprised of p-channel field effect transistors; the second determined stress is a compressive stress and the first thickness is less than the second thickness.

En teaches that a compressive stress enhances the performance of a PMOS device (col. 6, lines 47-51). Furthermore Tobben shows the formation DRAM structure with a plurality of NMOS and PMOS transistors.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form a second portion of the plurality of field effect transistors comprised of p-channel field effect transistors as claimed in the combined structure of En and Tobben in order to form a high performance DRAM structure.

Furthermore parameters such as thickness in the art of semiconductor manufacturing process are subject to routine experimentation and optimization to achieve the desired device quality during fabrication.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to adjust the thickness of the first and second thickness as claimed in the combined structure of En and Tobben in order to form a high performance DRAM structure.

Regarding claim 11, the combined structure of En and Tobben teaches substantially the entire claimed structure of claims 1, 9 and 10 except explicitly stating that a first plurality of n-channel field effect transistors having spacings between adjacent n-channel field effect transistors that fall within a first defined spacing range; a second plurality of n-channel field effect transistors having spacings between adjacent n-channel field effect transistors that fall within a second defined spacing range; a first plurality of p-channel field effect transistors having spacings between adjacent p-channel field effect transistors that fall within a third defined spacing range; a second plurality of p-channel field effect transistors having spacings between adjacent p-channel field effect transistors that fall within a fourth defined spacing range; a first tensile layer having a first tensile layer thickness and being configured to impart a first

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determined tensile stress to the first plurality of n-channel field effect transistors; a second tensile layer having a second tensile layer thickness and being configured to impart a second determined tensile stress to the second plurality of n-channel field effect transistors; a first compressive layer having a first compressive layer thickness and being configured to impart a first determined compressive stress to the first plurality of p-channel field effect transistors; and a second compressive layer having a second compressive layer thickness and being configured to impart a second determined compressive stress to the second plurality of p-channel field effect transistors.

Since the combined structure of En and Tobben established that both n-FET and p-FET can be arranged separately as in claims 9 and 10, therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to form both the n-FET and p-FET as claimed in order to form a high performance DRAM structure.

6. Claims 12-19 are rejected under 35 U.S.C. 103(a) as being unpatentable over En, Tobben and in view of Ngo et al. US patent No. 6,483,154.

Regarding claim 12, En teaches substantially the entire claimed structure of claim 11 above except explicitly stating that each of the first tensile layer; second tensile layer; first compressive layer and second compressive layer is deposited on an SiO₂ liner.

It is conventional in the art and also taught by Ngo (fig. 5) forming SiO₂ liner (23) with a spacer structure formed of SiN (24) in the structure of transistor.

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It would have been obvious to one of ordinary skill in the art at the time the invention was made to form oxide liner as taught by Ngo in the structure of En in order to improve adhesion between the stress layer and the semiconductor device.

Regarding claim 13, En teaches substantially the entire claimed structure of claim 11 above except explicitly stating that the first defined spacing range is less than the second defined spacing range; and the third defined spacing range is less than the fourth defined spacing range.

Parameters such as spacing and thickness in the art of semiconductor manufacturing process are subject to routine experimentation and optimization to achieve the desired device quality during fabrication.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to adjust the spacing of the first defined spacing, second defined spacing range and the third defined spacing as claimed in the combined structure of En, Tobben and Ngo in order to form a high performance DRAM structure.

Regarding claim 14, En teaches substantially the entire claimed structure of claim 11 above except explicitly stating the first tensile layer thickness is less than the second tensile layer thickness; and the first compressive layer thickness is less than the second compressive layer thickness.

Parameters such as thickness and spacing in the art of semiconductor manufacturing process are subject to routine experimentation and optimization to achieve the desired device quality during fabrication.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to adjust the first tensile layer, the second tensile layer thickness, the first compressive layer thickness and the second compressive layer thickness as claimed in the structure of En, Tobben and Ngo in order to form a high performance DRAM structure.

Regarding claim 15, En teaches substantially the entire claimed structure of claims 4 and 11 above including the first tensile layer thickness does not pose a substantial risk of void formation in the first tensile layer; and the first compressive layer thickness does not pose a substantial risk of void formation in the first compressive layer.

Regarding claim 16, En teaches substantially the entire claimed structure of claims 5 and 11 above including the first determined tensile stress enhances electron mobility in the first plurality of n-channel field effect transistors, without materially degrading performance of the first plurality of p-channel field effect transistors and the second plurality of p-channel field effect transistors; and the first determined compressive stress enhances hole mobility in the first plurality of p-channel field effect transistors, without materially degrading performance of the first plurality of n-channel field effect transistors and the second plurality of n-channel field effect transistors.

Regarding claim 17, En teaches substantially the entire claimed structure of claim 11 above except explicitly stating that the first tensile layer thickness is proportional to the first determined spacing range; the second tensile layer thickness is proportional to the second determined spacing range; the first compressive layer

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thickness is proportional to the third determined spacing range; and the second compressive layer thickness is proportional to the fourth determined spacing range.

Parameters such as thickness and spacing in the art of semiconductor manufacturing process are subject to routine experimentation and optimization to achieve the desired device quality during fabrication.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to adjust the first tensile layer, the second tensile layer thickness, the first compressive layer thickness and the second compressive layer thickness as claimed in the structure of En, Tobben and Ngo in order to form a high performance DRAM structure.

Regarding claim 18, En teaches substantially the entire claimed structure of claim 11 above including the first tensile layer, second tensile layer, first compressive layer and second compressive layer is a silicon nitride (col. 6, lines 38-51 and col. 7, lines 8-22).

Regarding claim 19, En teaches substantially the entire claimed structure of claim 11 above including that the first tensile layer and second tensile layer each exhibit a tensile stress of about 600 to 1500 MPa (En teaches 700MPa, col. 6, lines 40-50); and the first compressive layer and second compressive layer each exhibit a compressive stress of about -600 to -1500 MPa (En teaches -1000MPa, col. 6, lines 1-10).

Allowance

7. Claim 26 is allowed.

Reason for allowance

8. The following is an examiner's statement of reasons for allowance: The prior art of record does not teach or suggest, singularly or in combination at least the limitation of "forming a plurality of high and low density areas of nFETS and pFETS on a substrate, the high density areas exhibiting a gate to gate distance and the low density areas exhibiting a gate to gate distance; forming a thin compressive film in channel regions of the high density areas of pFETS exhibiting a compressive stress; forming a thin tensile film in channel regions of the high density areas of nFETS; forming a thick compressive film in channel regions of the low density areas of pFETS; forming a thick tensile film in channel regions of the low density areas of nFETS exhibiting a tensile stress" as recited in claim 26.

Response to Arguments

9. Applicant's arguments with respect to claims 1-25 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

10. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Samuel A. Gebremariam whose telephone number is (571) 272-1653. The examiner can normally be reached on 8:00am-4:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's acting supervisor, Steven Loke can be reached on (571) 272-1657. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

SAG
August 3, 2005

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